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Lip morphometric study on Indian Americans and its clinical applications

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Abstract
Objectives: The aim was to determine the normal average values of lip liner measurements and to determine any significant sex differences exists in Indian Americans.
Methods: The direct lip anthropometric measurements were carried out using digital caliper in 100 (men, women) Indian American students (18 to 30 years) of American University of Antigua (AUA), Antigua and compared between the sexes.
Results: Lip measurements showed higher value in men than women. Cutaneous height of upper lip was higher in both sexes. The lower lip height and vermilion height was higher in both sexes. Lip ratios were reliable as compared to other parameters except vermilion-cutaneous upper and lower lips height in both sexes.
Conclusion: Lip anthropometric data specific to Indian Americans will be useful if in case they need to undergo labiaplasty and lip enhancement surgeries and for establishing baseline data for forensic odontologists, plastic surgeons & orthodontists treating Indian Americans.

Keywords: Lip; morphometry; lower lip; upper lip.

1. Introduction

The lower one third of the face has a major impact on the perception of facial aesthetics (Anic-Milosevic *et al*., 2010) [1]. The lips comprise the key esthetic feature of the lower third of the face (Bisson and Grobbelaar, 2004) [2]. The lips contribute substantially to facial expressions such as a smile or frown. Upper lip has a shallow vertical groove, the philtrum which ends below in a slight tubercle limited by lateral ridges (Drake *et al*., 2005) [3]. The lower lip shows a small depression in the midline that corresponds to the tubercle (Standring and Wigley, 2005) [4].

Lip anthropometric parameters are affected by various factors including age, sex, ethnicity, socioeconomic status, environment and region (Parwati and Sawhney, 1997) [5]. The size and curvature of the exposed red lip surface is subject to considerable individual, sex and ethnic variation (Berkovitz and Standerij, 2005) [6]. In the lower lip the junction of the skin and the red lip area varies greatly in its vertical depth at the center in different individuals (Standring and Wigley, 2005) [4]. The lower lip is usually larger than the upper lip vertically (Ellis and Moore, 2002) [7].

In 2014, nearly 16 million cosmetic procedures were performed in the United States alone [8]. The number of cosmetic procedures performed in the United States has almost doubled since the start of the century. 92% of cosmetic procedures were performed on women in 2014 up from 88% in 2001 [9]. The increased use of cosmetic procedures crosses racial and ethnic lines in the U.S.A, with increases seen among African-Americans, Asian Americans and Hispanic Americans as well as Caucasian Americans. In Asia, cosmetic surgery has become more popular, and countries such as China and India have become Asia's biggest cosmetic surgery markets [10].

Anthropometry technique is widely used to analyze facial morphology in the field of medicine. In the field of facial anthropometry, Farkas' has done the research extensively in many ethnic groups (Farkas *et al*., 2005) [11]. Facial morphometry is well discussed in Caucasians (Farkas *et al*., 2005) [11] and African Americans (Ofodile *et al*., 1993) [12] but, only a limited number of studies exist for Asian Americans (Sim *et al*., 2000) [13].

Results of the studies conducted in certain ethnic groups or regions may not be applicable to the populations elsewhere (Siddiqui and Shah, 1944) [14]. Therefore there is a need for systematic study for each ethnic groups or region.

There are very few anthropometric studies that have dealt with different migrant ethnic groups in the USA. Indian Americans are the second-fastest growing ethnic group in the United States of America (USA). Most of the studies on lip anthropometric measurements in the USA have been done in Caucasians and therefore may not be applicable for Indian Americans.

It is desirable that studies should be carried out in different ethnic groups to establish normal reference values on different anthropometric measurements. A few studies have been conducted on lip anthropometry in Indian populations within India (Goel *et al*., 2015; Sinojiya *et al*., 2014; Gupta *et al*., 2014; Upadhyay *et al*., 2013; Jagadish Chandra *et al*., 2012; Khanderkar *et al*., 2005; Farkas *et al*., 2005) [11, 15-20]. But, the available literature search shows a study performed by Husein *et al* (2010) [21] dealing only with 100 Indian American Woman's face by using photographs. However, there are no reports available on the lip anthropometry with other parameters in Indian American population.

Lip anthropometric data specific to Indian Americans will be useful if in case they need to undergo labiaplasty and lip enhancement surgeries. This study seeks to expand scientific research on lip proportions for establishing baseline data for forensic odontologists, plastic surgeons & orthodontists treating Indian Americans in the USA.

Hence, the aim of the present study was to determine the normal average values of lip liner measurements in Indian

Americans, and if there are any significant differences exist in the measurements among the sexes.

2. Materials and Methods

2.1 Subjects

The study group consisted of 100 Indian American students of American University of Antigua (AUA), Antigua, with equal number of men and women. The age of the subjects ranged from 18-30 years. This study was approved by AUA ethics committee. The subjects with previous history of developmental and neurological defects of facial region, cosmetic treatment of mouth and lip region, cranio-facial trauma, facial surgery and bi-racial ethnic origins were excluded in this study.

This study was funded by School of Medicine, AUA, Antigua.

The study was explained and the standard informed consent was obtained from the participants prior to the study. The anthropometric landmarks were identified on the subjects with careful inspection and then marked on the face with black liquid eye liner (Table1) (Figures 1 and 2).

2.2 Landmarks (upper and lower lips) (Table1) (Figures 1 and 2)

Midline landmarks: sn, subnasale; ls, labiale superius; st, stomion; li, labiale inferius; sl, sublabiale. Paired landmarks: ch, cheilion.

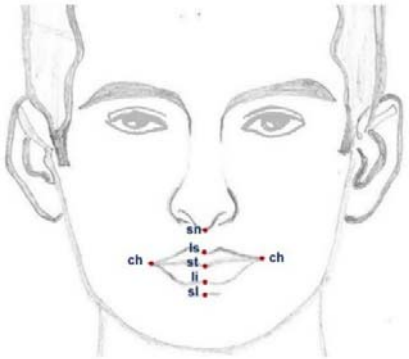

Fig 1: Photograph shows the lip anthropometric landmarks. sn, subnasale; ls, labiale superius; st, stomion; li, labiale inferius; sl, sublabiale. Paired landmarks: ch, cheilion

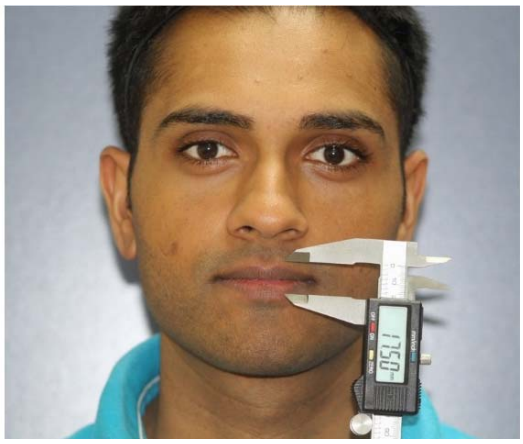

Fig 2: Photograph shows the sample lip linear measurement by using digital caliper.

Table 1: Anthropometric lip land marks

sn	subnasale	midpoint at the union of the lower border of the nasal septum and the upper lip
ls	labiale superius	midpoint of the vermilion line of the upper lip
st	stomion	midpoint of the horizontal labial fissure
li	labrale inferioris	midpoint of the vermilion line of the lower lip
sl	sublabiale	In the midline of the nasolabial sulcus
ch	cheilion	labial commissura

2.3 Position of the subjects

Subjects were asked to sit in an upright relaxed position "natural and normal" erect posture of head and shoulders, with both arms hanging free beside the trunk for the linear measurements of the face (Farkas *et al*., 2005) [11].

2.4 Direct Anthropometric measurements (Manual measurement) (Packiriswamy *et al*., 2012) [22]

The following measurements were done up to 0.5 degree and 0.5 mm accuracy on the subjects with maximum care and comfort by using Neiko 01407A stainless steel digital caliper with extra-large LCD (liquid crystal display) screen and instant SAE-metric (Society of Automotive Engineers) conversion, New York, USA. Every measurement was obtained thrice by the same observer. A third reading was taken if the initial two measurements showed a large discrepancy, and the two closer readings were used.

2.4.1 Lip linear distances (unit: mm) (Figure 3):

Cutaneous height of upper lip (philtrum (sn–ls))
Vermilion height of the upper lip (ls-st)
Upper lip height (sn-st)
Cutaneous height of lower lip (li-sl)
Vermilion height of the lower lip (st-li)
Lower lip height (st-sl)
Total vermilion height (ls-li)
Total lips height (sn-sl)
Outer intercommissural (mouth) width (ch-ch)

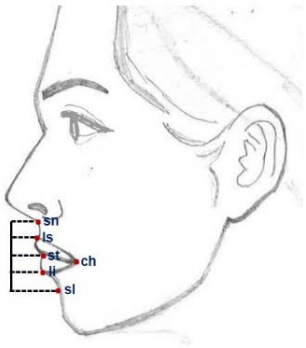

Fig 3: Photograph shows the anthropometric lip linear measurements. Cutaneous height of upper lip (philtrum (sn–ls)); vermilion height of the upper lip (ls-st); upper lip height (sn-st); cutaneous height of lower lip (li-sl); vermilion height of the lower lip (st-li); lower lip height (st-sl); total vermilion height (ls-li); total lips height (sn-sl); outer intercommisural (mouth) width (ch-ch).

2.4.2 Lip ratios

Ratio of vertical to vertical measurements:

Cutaneous-total upper lip height index (sn-ls/sn-st)

Vermilion-total upper lip height index (ls-st/sn-st)
Vermilion-cutaneous upper lip height index (ls-st/sn-ls)
Vermilion height index (ls-st/st-li)
Cutaneous-total lower lip height index (li-sl/st-sl)
Vermilion-total lower lip height index (st-li/st-sl)
Vermilion-cutaneous lower lip height index (st-li/li-sl)

Ratio of vertical to horizontal measurements:
Upper lip height-mouth width index (sn-st/ch-ch)
Lower lip height-mouth width index (st-sl/ch-ch)

2.5 Statistical analysis
Data was collected and analyzed in accordance with the current law about personal data and privacy. The statistical analysis was performed using "Graph pad instat" (Version 3.06, Graph pad Software Inc.), San Diego, CA. The lip linear distances were presented as range, mean and standard deviation (SD). The lip linear distances were compared between sexes by using "Independent t test". Values of $p < 0.05$ were considered as significant. Facial lip ratios were also calculated.

3. Results
The present study establishes the basal values for various parameters of the lips amongst the Indian Americans.

Descriptive statistics of the lip anthropometric measurements
The mean and standard deviation (SD) of lip linear anthropometric measurements of Indian Americans are shown in Table 2. The lip anthropometric measurements of Indian American men showed higher value when compared to women (Table 2).
On comparing cutaneous height of upper and lower lips, it was found to be higher in the case of upper lips in both sexes. The lower lip height was higher when compared to upper lip height in both sexes. The vermilion height of the lower lip was higher when compared to vermilion height of the upper lip in both sexes.

Table 2: Showing various parameters of lip morphometry in Indian American men and women

SN	Parameter in millimeter	Men (n=100)	Women (n=100)	p Value
		mean (SD)	mean (SD)	
1	Cutaneous height of upper lip (philtrum (sn–ls))	12.9 (2.54)	11.08 (2.61)	<0.0001***
2	Vermilion height of the upper lip (ls-st)	7.73 (1.77)	7.495 (1.48)	0.3103
3	Upper lip height (sn-st)	20.63 (2.88)	18.57 (2.54)	<0.0001***
4	Cutaneous height of lower lip (li-sl)	10.68 (2.83)	8.533 (2.67)	<0.0001***
5	Vermilion height of the lower lip (st-li)	12.14 (2.19)	11.09 (2.29)	0.0011**
6	Lower lip height (st-sl)	22.82 (3.50)	19.62 (2.48)	<0.0001***
7	Total vermilion height (ls-li)	19.87 (3.41)	18.59 (3.25)	0.007**
8	Total lips height (sn-sl)	43.45 (4.78)	38.19 (3.79)	<0.0001***
9	Outer intercommisural (mouth) width (ch-ch)	52.05 (3.81)	50.42 (4.61)	0.0069**
SN - serial number; SD - standard deviation; ***Highly significant (p<0.0001); **Significant (p<0.001)				

Comparison of the lip anthropometric measurements by sex
The lip anthropometric measurements are compared between the sexes by using "independent t test". Cutaneous height of upper lip, upper lip height, cutaneous height of lower lip, vermilion height of the lower lip, lower lip height, total vermilion height, total lips height and outer intercommissural (mouth) width in the Indian Americans showed statistically significant sexual difference while vermilion height of the upper lip showed no statistical significant sexual difference (Table 2).

Vertical to vertical lip measurements ratio in the sexes
The mean, standard deviation and coefficient of variation of vertical to vertical lip measurements ratio of Indian Americans are shown in Table 3 and 4. We have a very high coefficient of variation of vermilion-cutaneous upper lip height index (men and women), vermilion height index (women) and vermilion-cutaneous lower lip height index (men and women). We have low coefficient of variation of cutaneous-total upper lip height index, vermilion-total upper lip height index, cutaneous-total lower lip height index, and vermilion-total lower lip height index in both sexes (Table 3 and 4).

Table 3: Ratio of vertical to vertical measurements in Indian American men (n=100)

SN	Index	Ratio	Mean	SD	Min	Max	CV
1	Cutaneous-total upper lip height index	(sn-ls/sn-st)	0.62	0.07	0.47	0.77	11.91%
2	Vermilion-total upper lip height index	(ls-st/sn-st)	0.38	0.07	0.23	0.53	19.76%
3	Vermilion-cutaneous upper lip height index	(ls-st/sn-ls)	0.63	0.20	0.29	1.13	31.52%
4	Vermilion height index	(ls-st/st-li)	0.64	0.14	0.43	1.00	21.86%
5	Cutaneous-total lower lip height index	(li-sl/st-sl)	0.46	0.08	0.23	0.60	18.03%
6	Vermilion-total lower lip height index	(st-li/st-sl)	0.54	0.08	0.40	0.77	15.62%
7	Vermilion-cutaneous lower lip height index	(st-li/li-sl)	1.23	0.45	0.67	3.29	36.73%
SN - serial number; SD - standard deviation; CV - coefficiant of variation; Min - minimum; Max - maximum							

Table 4: Ratio of vertical to vertical measurements in Indian American women (n=100)

SN	Index	Ratio	Mean	SD	Min	Max	CV
1	Cutaneous-total upper lip height index	(sn-ls/sn-st)	0.59	0.09	0.38	0.76	14.53%
2	Vermilion-total upper lip height index	(ls-st/sn-st)	0.41	0.09	0.24	0.63	21.01%
3	Vermilion-cutaneous upper lip height index	(ls-st/sn-ls)	0.73	0.27	0.31	1.67	37.21%
4	Vermilion height index	(ls-st/st-li)	0.71	0.30	0.40	2.60	41.58%
5	Cutaneous-total lower lip height index	(li-sl/st-sl)	0.43	0.11	0.26	0.88	25.52%
6	Vermilion-total lower lip height index	(st-li/st-sl)	0.57	0.11	0.13	0.74	19.36%
7	Vermilion-cutaneous lower lip height index	(st-li/li-sl)	1.46	0.59	0.14	2.89	40.45%
SN - serial number; SD - standard deviation; CV - coefficiant of variation; Min - minimum; Max - maximum							

Vertical to horizontal lip measurements ratio in the sexes

The mean, standard deviation and coefficient of variation of vertical to horizontal lip measurements ratio of Indian Americans are shown in Table 5 and 6. The upper lip height-mouth width index, and lower lip height-mouth width index are quiet reliable with coefficient of variation in both sexes (Table 5 and 6).

Table 5: Ratio of vertical to horizontal measurements in Indian American men (n=100)

SN	Index	Ratio	Mean	SD	Min	Max	CV
1	Upper lip height-mouth width index	(sn-st/ch-ch)	0.40	0.06	0.27	0.56	15.81%
2	Lower lip height-mouth width index	(st-sl/ch-ch)	0.44	0.07	0.30	0.60	15.92%
SN - serial number; SD - standard deviation; CV - coefficiant of variation; Min - minimum; Max - maximum							

Table 6: Ratio of vertical to horizontal measurements in Indian American women (n=100)

SN	Index	Ratio	Mean	SD	Min	Max	CV
1	Upper lip height-mouth width index	(sn-st/ch-ch)	0.37	0.05	0.22	0.53	14.19%
2	Lower lip height-mouth width index	(st-sl/ch-ch)	0.39	0.07	0.27	0.57	16.91%
SN - serial number; SD - standard deviation; CV - coefficiant of variation; Min - minimum; Max - maximum							

4. Discussion

The distances and divisions in the lower third of the face are one of the most important in the evaluation of facial beauty, given the fact that the lips and the chin highly determinate women beauty (Anic-Milosevic *et al*., 2010) [1].

Comparison of the present study with other studies revealed variations and similarities in the lips measurement. The lip results were compared with the other available data for Indian, Indian American, Malaysian Indians and North American Whites as given in Tables 7 and 8. In Table 7 we have compared men of the present study with men of previous studies and in Table 8 comparison of women of the present study with women of previous studies.

In the present study, the lip anthropometric measurements of Indian American men showed higher value when compared to Indian American women. On comparing the mean values of the cutaneous height of upper and lower lips, it was found to be higher in the case of upper lips in both sexes. The mean values of the cutaneous height of upper lip was in consistency with previous studies done on Indians and Malaysian Indians by other workers (Goel *et al*., 2015; Ngeow & Alijunid, 2009) [15, 23] whereas the mean values of the cutaneous height of upper lip observed was higher in the studies conducted on Indians and North American Whites (Gupta *et al*., 2014; Upadhyay *et al*., 2013; Khanderkar *et al*., 2005; Farkas *et al*., 1984) [17, 18, 20, 24].

On comparing the mean values of the vermilion height of upper and lower lips, it was found to be higher in the case of lower lips in both Indian American sexes. The mean values of the vermilion height of upper lip was in consistency with previous studies done on Indians and North American Whites by other workers (Jagadish Chandra *et al*., 2012; Farkas *et al*., 1984) [19, 24] whereas the mean values of the vermilion height of upper lip observed was higher in the other studies conducted on Indians, Indian American women, Malaysian Indians and North American Whites (Goel *et al*., 2015; Jagadish Chandra *et al*., 2012; Anic-Milosevic *et al*., 2010; Husein *et al*., 2010; Ngeow & Alijunid, 2009; Farkas *et al*., 2005) [1, 11, 15, 19, 21, 23].

The mean values of the vermilion height of lower lip was in consistency with previous studies done on Indians and Malaysian Indians by other workers (Jagadish Chandra *et al*., 2012; Ngeow & Alijunid, 2009) [19, 23] whereas the mean values of the vermilion height of lower lip observed was lower in the studies conducted on Indian men, Indian American women and North American Whites (Goel *et al*., 2015; Anic-Milosevic *et al*., 2010; Husein *et al*., 2010; Farkas *et al*., 2005; Farkas *et al*., 1984) [1, 11, 15, 21, 24].

In the present study, the lower lip height was higher when compared to upper lip height in both sexes. The lower lip height in men showed higher value when compared to women. These results due to higher values of the cutaneous height of upper lips and vermilion height of the lower lips in both sexes. These results support the findings that sexual dimorphism does exist and showed the statistically significant difference between the sexes.

On comparing the mean value of the outer intercommissural width, it was found to be higher in the case of Indian American men when compared to Indian American women. The mean values of the outer intercommissural width was in consistency with previous studies done on North American White women by other workers (Farkas *et al*., 2005; Farkas *et al*., 1984) [11, 24]. The mean values of the outer intercommissural width observed was lower in the studies conducted on Indians (Goel *et al*., 2015) [15], Malaysian Indians (Ngeow & Alijunid, 2009) [23] and Indian women (Khanderkar *et al*., 2005; Farkas *et al*., 2005) [11, 20] whereas the outer intercommissural width was

higher in the studies conducted on Indian (Khanderkar *et al*., 2005) [20] and North American White men (Farkas *et al*., 2005; Farkas *et al*., 1984) [11, 24].

The lip ratio results were compared with the other available data for Indians, Indian American women, and North American Whites as given in Table 9. We have a very high coefficient of variation of vermilion-cutaneous upper lip height index (men and women), vermilion height index (women) and vermilion-cutaneous lower lip height index (men and women) thus making them far more unreliable as compared to other parameters. Other parameters that are quiet reliable include cutaneous-total upper lip height index, vermilion-total upper lip height index, cutaneous-total lower lip height index, The upper lip height-mouth width index, lower lip height-mouth width index and vermilion-total lower lip height index in both sexes. We had taken all the parameters of lip ratios in Indian Americans, but in previous studies not even a single study had taken all the parameters.

The upper lip height-mouth index in Indian American man was consistency with previous studies done on Indians and North American Whites by other workers (Kalra *et al*., 2015; Jagadish Chandra *et al*., 2012; Farkas *et al*., 1984) [19, 24, 25] whereas the upper lip height-mouth index in Indian American women observed was consistency with the study conducted on Indians (Kalra *et al*., 2015) [25] and higher in studies done on North American Whites (Farkas *et al*., 2005; Farkas *et al*., 1984) [11, 24].

Variations in the facial morphology arise through number of factors which include gender, race, dietary, climate, and environment where we live (Wankhede *et al*., 2012) [26]. Kunjur *et al*. (2006) [27] suggested that the aesthetic standards of a particular group may not suit other patients belonging to diverse racial and ethnic background.

It becomes clear from the available literature/data that the soft tissue relationship of Indian adults differs from the North American White standards or others and cannot be applied on each other. Therefore, these findings suggest that it will help to correct the inappropriateness of using other population data as different populations need different standards to carry out cosmetic surgery. The mean values for all parameters of lip morphometry reported in the literature by different scientists vary in different populations. This could be due to several factors such as differences in age, number of subjects, gender of the subjects and geographical conditions, moreover the method adopted.

Table 7: Compilation of lip measurements in Indian, Indian American and North American White Men (mm).

	Population	**(sn–ls)**	**(ls-st)**	**(sn-st)**	**(li-sl)**	**(st-li)**	**(st-sl)**	**(ls-li)**	**(sn-sl)**	**(ch-ch)**
Present study	**Indian American**	**12.9**	**7.73**	**20.6**	**10.68**	**12.1**	**22.82**	**19.9**	**43.45**	**52.05**
Anic-Milosevic *et al*. (2010) [1]	Caucasian	----	8.3	23.55	----	8.67	18.92	----	----	----
Farkas *et al*. (2005) [11]	North American White	----	----	----	----	----	----	----	----	53.3
Farkas *et al*. (2005) [11]	Indian	----	----	----	----	----	----	----	----	51
Goel *et al*. (2015) [15]	Indian	12.53	8.85	20.51	7.91	9.7	16.01	19.5	----	47.18
Sinojiya *et al*. (2014) [16]	Indian	11.2	----	17.83	12.75	----	39.87	----	----	----
Gupta et a. (2014) [17]	Indian	16.08	----	----	----	----	----	----	----	----
Upadhyay *et al*. (2013) [18]	Indian	14.94	----	22.75	14.09		50.63	----	----	----
Jagadish Chandra *et al*. (2012) [19]	Indian	----	8.31	22.63	----	11.3		----	----	----
Khanderkar *et al*. (2005) [20]	Indian	16.2		----	----	----	----	----	----	53.5
Ngeow & Alijunid (2009) [23]	Malysian Indian	12.9	9.2	21.6	----	12	----	----	----	48
Farkas *et al*. (1984) [24]	North American White	16.7	7.4	22.7	11.9	8.8	18.8	----	----	54.1
Cutaneous height of upper lip (sn-ls); vermilion height of the upper lip (ls-st); upper lip height (sn-st); cutaneous height of lower lip (li-sl);vermilion height of the lower lip (st-li); lower lip height (st-sl); total vermilion height (ls-li); total lips height (sn-sl); outer intercommissural width (ch-ch)										

Table 8: Compilation of lip measurements in Indian, Indian American and North American White Women (mm).

	Population	**(sn–ls)**	**(ls-st)**	**(sn-st)**	**(li-sl)**	**(st-li)**	**(st-sl)**	**(ls-li)**	**(sn-sl)**	**(ch-ch)**
Present study	**Indian American**	**11.1**	**7.49**	**18.57**	**8.53**	**11.1**	**19.62**	**18.6**	**38.2**	**50.4**
Anic-Milosevic *et al*. (2010) [1]	North American White	----	8.52	20.57	----	8.6	17.67	----	----	----
Farkas *et al*. (2005) [11]	Indian	----	----	----	----	----	----	----	----	46.5
Farkas *et al*. (2005) [11]	North American White	----	8.7	20.1	----	9.4	----	----	----	49.8
Goel *et al*. (2015) [15]	Indian	11.18	8.06	18.72	7.03	9.15	14.57	18.15	----	44.27
Sinojiya *et al*. (2014) [16]	Indian	9.68	----	16.93	11.52	----	37.6	----	----	----
Gupta et a. (2014) [17]	Indian	13.48	----	----	----	----	----	----	----	----
Upadhyay *et al*. (2013) [18]	Indian	13.68	----	20.79	12.59	----	45.79	----	----	----
Jagadish Chandra *et al*. (2012) [19]	Indian	----	7.8	22.92	----	12.14	----	----	----	----
Khanderkar *et al*. (2005) [20]	Indian	14.2	----	----	----	----	----	----	----	47
Husein *et al*. (2010) [21]	Indian American	----	8.3	18.6	----	10.1	----	----	----	----
Ngeow & Alijunid (2009) [23]	Malysian Indian	11.1	8.6	19.4	----	10.9	----	----	----	45.9
Farkas *et al*. (1984) [24]	North American White	13.3	7.7	19.6	9.9	9	16.7	----	----	50.6
Cutaneous height of upper lip (sn-ls); vermilion height of the upper lip (ls-st); upper lip height (sn-st); cutaneous height of lower lip (li-sl); vermilion height of the lower lip (st-li); lower lip height (st-sl); total vermilion height (ls-li); total lips height (sn-sl); outer intercommisural width (ch-ch)										

Table 9: Compilation of lip ratios in Men & Women

	Present study		Kalra *et al*. (2015) [25]		Jagdish chadra *et al*. (2012) [19]		Farkas *et al*. (1984) [24]		Farkas *et al*. (2005) [11]	
	Indian	American	Indian		Indian		North Am. White		North Am. White	
	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women
(sn-ls/sn-st)	0.62	0.59	----	0.5	----	----	----	0.69	----	----
(ls-st/sn-st)	0.38	0.41	----	0.54	----	----	----	0.43	----	----
(ls-st/sn-ls)	0.63	0.73	----	1.11	----	----	----	0.71	----	----
(ls-st/st-li)	0.64	0.71	----	0.81	----	----	----	0.87	----	----
(li-sl/st-sl)	0.46	0.43	----	----	----	----	----	----	----	----
(st-li/st-sl)	0.54	0.57	----	----	----	----	----	----	----	----
(st-li/li-sl)	1.23	1.46	----	----	----	----	----	----	----	----
(sn-st/ch-ch)	0.40	0.37	----	0.36	0.46	0.47	0.46	0.4	0.41	0.39

Vermilion-cutaneous upper lip height index (ls-st/sn-ls); Vermilion height index (ls-st/st-li); Cutaneous-total lower lip height index (li-sl/st-sl); Vermilion-total lower lip height index (st-li/st-sl); Vermilion-cutaneous lower lip height index (st-li/li-sl); Upper lip height-mouth width index (sn-st/ch-ch)

4.1 Strengths

In this study, number of cases was more as compared to previous studies except the study conducted by Goel *et al*. (2015) [15]. We had taken all the parameters of lip region, but in previous studies not even a single study had taken all the parameters.

The studies done on Indians (Gupta *et al*., 2014; Sinojiya *et al*., 2014; Upadhyay *et al*., 2013) [16-18], Caucasians (Anic-Milosevic *et al*., 2010) [1] and Indian American women (Husein *et al*., 2010) [21] were based on photographic data. The results possibly due to difference in methodology. The present study has been done by direct measurements, which is more reliable. Significant difference was observed between men and women when compared to the present study; working on live material is found to be superior over photograph. No authentic published data on the Indian American population was available and the available data from the Indian population and Indian American women was significantly different. Hence the need for baseline data for such a big Indian Americans in USA though earlier published data on Indians and North American Whites have shown significant racial differences. The present study clinches on to the racial significant data apart from sex dimorphism.

4.2 Weakness

The climate, dietary, and environment are different in USA when compared to India. The Indian Americans born and bought up in USA environment are quite high. Parameters can be affected by all these factors. But this will not harm the study because our primary aim is to generate preliminary data and this will provide useful information and will be helpful in further study.

4.3 Further Perspectives

Further research is very much required to lay down the standards of adoption for cosmetic surgery; however, these preliminary data will provide useful information.

4.4 Implications for medical practices

Knowledge of the proportions between the upper and lower lips helps in surgical correction of the lower face region. The study has provided vital data which will be helpful in reconstructive surgery. Surgeons can determine the goal preoperatively by:

1. Calculating proportion indices and whether they lie in the ethnic range or not.
2. Identifying areas with disproportion and defining extent of changes needed in numerator or denominator of index.

It is impossible to specify any distinct characteristic exclusively to a particular race, but careful examination of physical, skeletal and dental structures may collectively support the racial identity of an individual. The recognition of inherited racial characteristics is essential in forensic investigation for determining personal identification. It is expected that this study will provide useful information to the forensic, plastic surgeons and the forensic experts. In other words it can be useful for cosmetic correction purpose as well as for identification.

All of these bear different proportions to each other in the two sexes, which may be useful for cosmetic surgeons. However, these represent average values and not the optimal ones that make the face attractive. One should not forget that every individual is a unique creature. Reconstructive surgeons may use these parameters, but at the same time must be familiar with the methods of objectively judging facial harmony and proportion. They need to know how to arrange linear distances, inclination and proportions of the area undergoing surgery while allowing some asymmetries.

5. Conclusion

The lip anthropometric measurements of Indian American men showed higher value when compared to women. On comparing cutaneous height of upper and lower lips, it was found to be higher in the case of upper lips in both sexes. The lower lip height was higher when compared to upper lip height in both sexes. The vermilion height of the lower lip was higher when compared to vermilion height of the upper lip in both sexes. We had a very low coefficient of variation in all the lip ratios (vertical to vertical and vertical to horizontal) thus making them far more reliable as compared to other parameters except vermilion-cutaneous upper and lower lips height in both sexes.

Indian American men and women differ significantly in certain parameters from Indians, Caucasians, North American whites and Indian American Women but show resemblance to Malaysian Indians and it concludes that the same standards cannot be used on different populations for cosmetic surgery.

The present study's lip anthropometric data can be used as a reference value for Indian Americans which can be made use of if they need to undergo surgical reduction and reshaping of

the labia and surgical improvement of lips' fullness through enlargement in the USA.

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Conflict of interest
There are no conflicts of interest to disclose.

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